Chapter 8
Engineering Considerations for Construction

8-1. General

This chapter addresses engineering considerations for sheet pile wall construction. Its intent is to give design and construction engineers an overview of installation and its effect on the design.

8-2. Site Conditions

Site conditions should be evaluated during the reconnaissance phase, with effort increasing as the design progresses. Overhead and underground obstructions, such as pipes, power lines, and existing structures, may dictate special construction techniques. Some situations may even necessitate a change in wall alignment. The effects of pile driving on nearby structures or embankments should also be considered.

8-3. Construction Sequence

a. Interim protection. Construction of a new floodwall sometimes requires removal of the existing protection. In that situation it is necessary to provide interim protection or to construct the new wall in stages. Interim protection should be to the same level as the removed protection line. Staged construction should limit the breach to one that can be closed should floodwaters approach.

b. Relocations. Overhead utility lines are relocated temporarily for most sheet pile walls. Subsequent to pile driving, the lines can usually be placed back in their original position. Underground lines are removed for pile driving and then placed back through the sheet pile. Temporary bypass lines are necessary for some situations. Permanent relocation through the wall must allow for differential settlement between the wall and the utility lines.

8-4. Earthwork

a. Excavation. Excavation consists of the removal and disposal of material to the grades and dimensions provided on the plans. Excavation is generally required when capping or trenching sheet pile and for placement of tie rods or anchors. A dewatering system consisting of sumps and pumps or wells may be required depending on subsurface conditions. An excavation and dewatering plan should be submitted by the contractor for review prior to commencement of work.

b. Voids due to driving. During pile driving operations, voids may form adjacent to the webs and flanges of the sheet piling due to soil drawdown. Typically, these voids are first pumped free of any water present, either due to seepage or rain, and then backfilled with a cement-bentonite-sand slurry. The slurry should be fluid enough to fill the voids and strong enough to approximate the strength of the insitu material.

c. Backfill. It is recommended that clean sands and gravels be used as backfill for retaining walls whenever possible. Material placed behind the wall should be compacted to prevent settlement. The amount of compaction required depends on the material used. Over compaction could induce additional lateral pressures that may not have been accounted for in the design. Typically, granular fill is placed in thin lifts, with each lift compacted before the next is placed. If backfill is to be placed on both sides of a wall, placement should be in simultaneous equal lifts on each side. There are some situations in which the use of clay backfill is unavoidable, as in backfill for walls in levees. Under these circumstances very strict controls on compaction are required.

8-5. Equipment and Accessories

a. General. The most common methods of installing sheet pile walls include driving, jetting, and trenching. The type of sheet piling often governs the method of installation. Contract specifications should prohibit the installation of sheet piling until the contractor's methods and equipment are approved.

b. Hammers. Types of driving hammers allowed for sheet piles include steam, air, or diesel drop, single-action, double-action, differential-action, or vibratory. The required driving energy range should be specified in foot-pounds based on the manufacturer's recommendations and the type of subsurface that will be encountered. Vibratory hammers are widely used because they usually can drive the piles faster, do not damage the top of the pile, and can easily be extracted when necessary. A vibratory hammer can drive piling up to eight times faster than impact hammers depending on the type of subgrade. When a hard driving condition is encountered, a vibratory hammer can cause the interlocks to melt. If the penetration rate is 1 foot or less per minute, the use of a vibratory hammer should be discontinued

and an impact hammer should be employed. The selection of the type or size of the hammer is based on the soil in which the pile is driven. The designer should be aware of the soil stiffness and possibility of obstructions which could cause failure or weakening of the sheet pile during driving.

c. Guides and Templates. To ensure that piles are placed and driven to the correct alignment, a guide structure or templates should be used. At least two templates should be used in driving each pile or pair of piles. Templates should also be used to obtain the proper plumbness of the sheet pile wall. Metal pilings properly placed and driven are interlocked throughout their length.

d. Accessories. A protective cap should be employed with impact hammers to prevent damage to the tops of the piling. Protective shoes to protect the tip are also available so that driving through harder soil strata is possible. If an obstruction is encountered during driving, it should be removed or penetrated with a chisel beam. During driving, the piling next to the one being driven may tend to follow below the final design elevation; in this case it may be necessary to pin inplace piles together before the next pile is driven. Extraction, or pulling of specific piles for inspections, may be required if damage to the pile or interlocks is suspected or if excessive drift occurs. The circumstances should be carefully investigated to determine the cause of damage, and remedial action should be taken before redriving.

8-6. Storage and Handling

a. Steel piling. Steel piling may be damaged when mishandled or stored improperly, resulting in permanently bent sheets. Piling stored on site should not exceed stack height and weight as shipped from the mill. Blocking is used to maintain piling in a level position. Blocking between bundles should be located directly over any blocking placed immediately below. Slings or other methods that prevent buckling during lifting are typically used on long lengths of steel piling. Sheets over 80 feet in length should be handled using a minimum of two pick-up points. Additional care is required when handling piling with protective coatings, and any damaged area will require repairs prior to driving.

b. Hot-rolled and cold-formed steel sections. The following are suggested blocking procedures for certain popular hot-rolled and cold-rolled steel sections:

(1) Blocking for PZ-40 and PZ-35 sheet pile sections should be spaced no more than 15 feet apart and no more than 2 feet from the ends.

(2) Blocking for PZ-21, PZ-22, PSA-23, PS-27.5, and PS-31 sheet pile sections should be spaced no more than 10 feet apart and no more than 2 feet from the ends.

(3) Blocking for SPZ-22, SPZ-23.5, SPZ-23, SPZ-26, FZ-7, and FZ-9 sheet pile sections should be spaced no more than 12 feet apart and no more than 2 feet from the ends.

Light-duty steel, aluminum, concrete, and plastic sheet piles are not commonly used for structural sheet pile walls and should be stored and handled according to the manufacturer’s recommendations.

8-7. Methods of Installation

a. Driving. Sheet piling is typically driven with traditional pile driving equipment. The sheet piles are aligned using templates or a similar guiding structure instead of leads. For further information on pile driving equipment see EM 1110-2-2906.

b. Jetting. Pilings should not be driven with the aid of water jets without authorization of the design engineer. Jetting is usually authorized to penetrate strata of dense cohesionless soils. Authorized jetting should be performed on both sides of the piling simultaneously and must be discontinued during the last 5 to 10 feet of pile penetration. Adequate provisions must be made for the control, treatment, and disposal of runoff water.

c. Trenching. Under certain conditions it may be necessary to install a sheet pile wall by means of a trench. Trenching is usually done when the pile penetration is relatively shallow and there is a controlling factor which precludes driving. The backfill material on both sides of the trenched sheet pile wall should be carefully designed.

8-8. Driveability of Sheet Piling

a. Steel. Steel sheet piles are the most common and are usually placed by driving. The two types of steel sheet piles, hot-rolled and cold-rolled, have different driving considerations. Cold-rolled sections have a weaker interlock than the hot-rolled sections and in hard driving conditions this interlock might "unzip" or cause alignment problems which would require replacement of

the sheet piles. The cold-rolled sections also are usually thin and may be prone to overstressing during driving. The hot-rolled piles can be similarly damaged, but their interlocks are a ball- and socket-type connection which can "pop" if hard driving conditions are encountered.

b. Concrete. Concrete sheet piles usually cannot be driven with high-energy impact hammers without damaging the pile. They act as displacement piles and often require jetting to be driven. They are often trenched in place because they are usually used in low decorative walls which have a shallow depth of penetration.

c. Aluminum, timber, and plastics. These types of sheet piles are usually driven with light construction equipment, such as backhoes or jackhammers, to prevent damage to the piling. Walls composed of these materials are often trenched in place.

8-9. Tolerances

a. Driving. A vertical tolerance of plus or minus 1 1/2 inches, from the design elevation, is usually permitted. Sheet piling should not be driven more than 1/8 inch per foot out of plumb either in the plane of the wall or perpendicular to the plane of the wall.

b. Excavation. Generally, for an excavated surface on which concrete will be placed, the allowable vertical tolerance is 1/2 inch above line and grade and 2 inches below. For all other areas, vertical and horizontal tolerances of 6 inches, plus or minus, from the specified grade are usually permitted. Neither extremes of these tolerances should be continuous over an area greater than 200 square feet. Abrupt changes should not be permitted.

8-10. Anchors

Improperly planned construction methods may produce loads which exceed those used for design. Anchor forces, soil pressures, and water loads are affected by the method of construction and construction practices. The sequence of tightening tie rods should be specified to prevent overstresses in isolated sections of the wale or the sheet pile wall. Anchors and tie rods should be placed and tightened in a uniform manner so that no overstresses may occur. Backfilling above the anchor elevation should be carefully controlled to prevent bending of the tie rods. The backfill material should be controlled, and the thickness of compacted layers should be limited to ensure proper compaction and drainage of the backfill material.